

Lower Devonian (Emsian) Microfauna from the Gamilaroi Terrane at Glenrock in the Southern New England Orogen, New South Wales

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Radiolarians and conodonts extracted from ribbon-bedded tuffaceous chert and interbedded limestones and shales of the Frog Hollow Formation (Gamilaroi Terrane) at Bralga Tops, Glenrock Station indicate a Lower Devonian (Emsian) age. The radiolarian fauna includes *Helenifore laticlavium* Nazarov and Ormiston, *Palaeoscenidium cladophorum* Deflandre, *Ceratoikiscum* sp., *Trilonche hindea* (Hinde), *Trilonche vetusta* Hinde, *Trilonche echinata* (Hinde), and *Trilonche elegans* (Hinde) which represents the Emsian *Helenifore laticlavium* assemblage. The conodont fauna includes *Polygnathus* cf. *serotinus* Telford, *Ozarkodina* cf. *prolata* Mawson and *Pandorinellina expansa* Uyeno and Mason? which suggest an upper Emsian age.

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REGIONAL SETTING

The microfossils described in this study were collected from the Siluro-Devonian Gamilaroi Terrane (Flood and Aitchison 1988, Aitchison and Flood 1994), the westernmost terrane in the New England Orogen. This terrane comprises a complex association of volcanoclastic sediments, tuffs, volcanic rocks and minor carbonates formed in an intra-oceanic island-arc setting (Aitchison and Flood 1994, Stratford and Aitchison 1996) which accreted to the eastern margin of Gondwana sometime during the Late Devonian (Flood and Aitchison 1992). Unconformably overlying Upper Devonian to Carboniferous sedimentary and volcanic rocks which formed along the continental margin of Gondwana are interpreted as an overlap assemblage which developed on top of the Gamilaroi Terrane after its accretion to the Gondwana margin. The Gamilaroi Terrane and its overlying Carboniferous volcano-sedimentary overlap assemblage are often together referred to as a structural entity, the Tamworth Belt (Korsch 1977).

Gamilaroi Terrane strata in the southern New England Orogen have an arcuate distribution pattern throughout northeastern NSW over a distance of approximately 450 km. Local lithostratigraphies have been developed in several areas of Gamilaroi Terrane outcrop and a lithostratigraphic succession within the terrane was first described from Nundle (Crook 1961; Cawood 1983). With varying success, formations within the Tamworth Group can be traced along strike for approximately 120 km from Attunga through Tamworth to Nundle. The terrane can be followed further southeast to the Upper Barnard River catchment where a different local lithostratigraphic subdivision has been

developed (Stratford and Aitchison in press). Tamworth Group lithostratigraphy cannot easily be traced to this area due to inherent variations in sedimentation patterns in the Gamilaroi Terrane depositional setting. Lithostratigraphic units recently described from the Upper Barnard catchment southwest of Nundle (Aitchison and Stratford in press, Stratford and Aitchison in press) can be traced from Barry through Glenrock to Pigna Barney (approx. 100 km). The microfauna reported herein comes from localities within the Frog Hollow Formation. This formation is the lowest sedimentary unit and overlies the Pitch Creek Volcanics which form the basement to the terrane.

The sampled outcrops occur within the Gamilaroi Terrane at Glenrock station. The sequence in which the limestones occur is incompletely exposed and their relations to adjacent strata cannot be confirmed. They appear to overlie altered felsic volcanic rocks of the Pitch Creek Volcanics but the possibility of an allochthonous origin cannot be excluded. The limestones lie on the east side of a fault which cuts through the low pass between the fossiliferous outcrops. The fault lies entirely within the Gamilaroi Terrane and is marked by serpentinite. Total displacement is indeterminate. On the west side of the fault highly altered purple coloured pillow basalts are overlain by tuffaceous radiolarian-bearing cherts (Figure 1).

RADIOLARIAN FAUNA

Several rock chip samples, of approximately 300 g each, were collected from a large, 20 m wide, road cutting outcrop of ribbon-bedded tuffaceous chert in the Frog Hollow Formation (Stratford and Aitchison in press) at Bralga Tops (Glenrock 1:25000 NSW CMA mapsheet 9134-I-S GR 543957; Fig. 1).

A diverse, well preserved radiolarian fauna was recovered from three samples (Plates 1, 2). The fauna includes *Helenifore laticlavium* Nazarov and Ormiston, *Palaeoscenidium cladophorum* Deflandre, *Ceratoikiscus* sp., *Trilonche hindea* (Hinde), *Trilonche vetusta* Hinde, *Trilonche echinata* (Hinde), and *Trilonche elegans* (Hinde). Unfortunately many other radiolarians present are entactiniids which are only referable to as *Trilonche* spp. or *Stigmatosphaerostyla* spp. Precise diagnosis of these fossils depends on examination of internal detail which is almost invariably lacking.

CONODONT FAUNA

Conodonts were extracted from a single large (22.5 kg) channel sample (No. 1131) of limestone collected from an approximately 10 m thick section of interbedded limestones and shales exposed in a ditch and road cutting (Glenrock 1:25000 NSW CMA mapsheet 9134-I-S GR 545958; Fig. 1) at Bralga Tops on Glenrock Station, approximately 90km northeast of Scone, NSW.

The following conodont elements were recovered from the sample:

<i>Ozarkodina</i> cf. <i>prolata</i> Mawson	Pa	27
<i>Panderodus unicostatus</i> Branson and Mehl	Sa	1
<i>Pandorinellina expansa</i> Uyeno and Mason?	Pa	1
<i>Polygnathus</i> cf. <i>serotinus</i> Telford	Pa	1
<i>Neopanderodus aequabilis</i> Telford	Sa	3
	Sb	1
	M	2
unidentified	Pb	2
unidentified	Sc	2
unidentified fragments		25
TOTAL		65

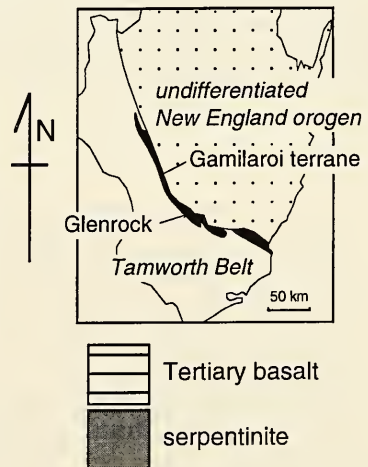
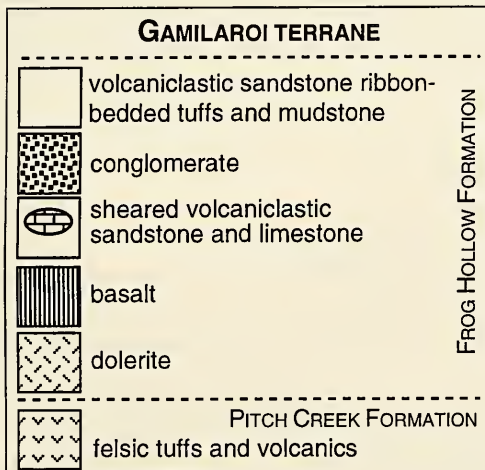
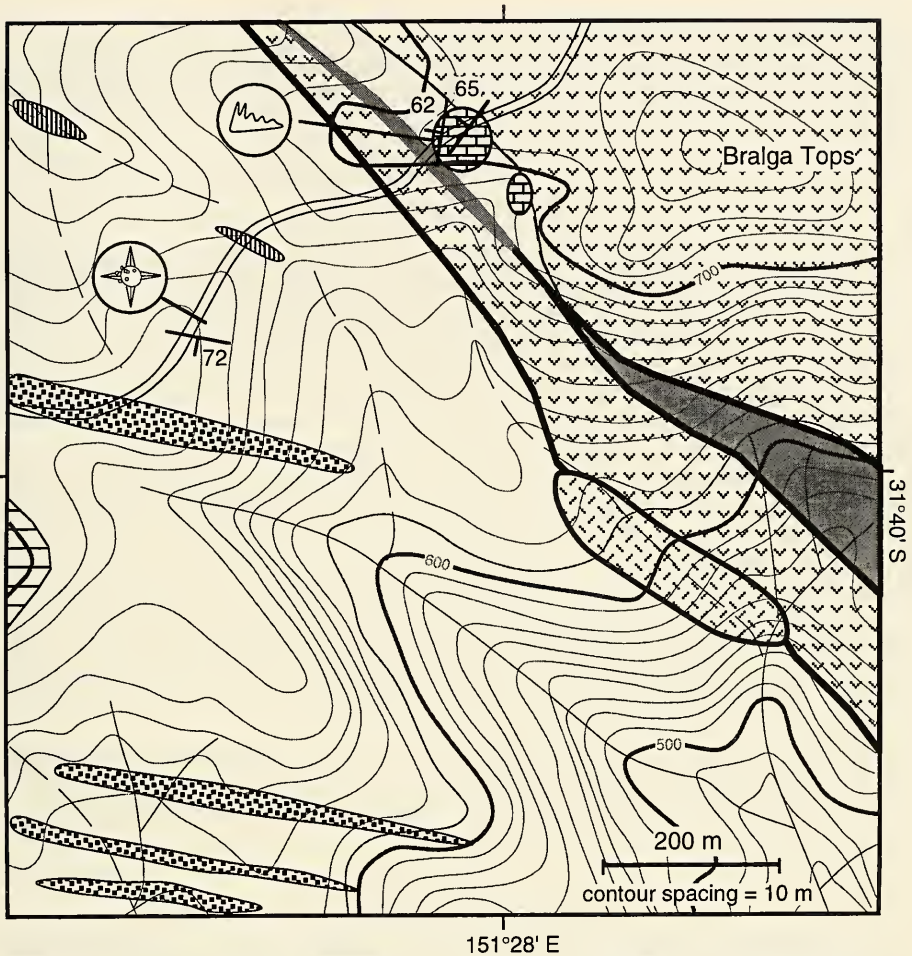


Figure 1: Distribution of Gamilaroi Terrane lithologies in the Bralga Tops locality showing the location of fossil radiolarian and conodont samples.

Conodont Colour Alteration Index

The conodonts exhibit a Conodont Colour Alteration Index (CAI) of 4 which indicates that the conodont elements have been heated to between 190°C and 300°C (Epstein et al. 1977).

AGE OF THE FAUNAS

The single Pa element of *Polygnathus* cf. *serotinus* Telford is morphologically close to *Polygnathus serotinus* except that the lip on the outer side of the basal cavity is not well developed. This specimen may be a transitional form between *Polygnathus serotinus* and its ancestral species *Polygnathus inversus* Klapper and Johnson, suggesting a late Emsian age. The twenty-seven elements of *Ozarkodina* cf. *prolata* Mawson are morphologically close to *Ozarkodina prolata* Mawson and have the same shape and position of the basal cavity. However, the anterior-most denticles of the blade are not as high as those of *Ozarkodina prolata* Mawson. An Emsian age is again indicated by this form. The one specimen of *Pandorinellina* is tentatively identified as *Pandorinellina expansa* Uyeno and Mason but the denticles of the blade are broken precluding confirmation of this assignment. The position and shape of the basal cavity is however consistent with *Pandorinellina expansa* Uyeno and Mason. This species is known from the late Emsian *Polygnathus costatus patulus* and *Polygnathus serotinus* zones (Mawson et al. 1995). A Late Emsian age is therefore suggested by the conodont elements recovered. The presence of *Panderodus unicostatus* Branson and Mehl, which has a stratigraphical range from Middle Ordovician to Middle Devonian, and *Neopanderodus aequabilis* Telford, which occurs in the Lower and Middle Devonian, is consistent with an Emsian age.

Radiolarians are equivalent to those found elsewhere in lowermost stratigraphic portions of the Gamilaroi Terrane in southern New England and are equated with the Emsian *Helenifore laticlavium* assemblage of Stratford and Aitchison (1996, 1997).

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REFERENCES

- Aitchison, J.C. and Flood, P.G. (1994). Gamilaroi Terrane: a Devonian rifted intra-oceanic island arc assemblage, NSW, Australia. In 'Volcanism associated with extension at consuming plate margins' (Ed. J. L. Smellie) pp. 155–168. Geological Society, London Special Publication 81.
- Aitchison, J.C. and Stratford, J.M.C. (in press). Geology of the Upper Barnard Region, New England Orogen, eastern NSW, Australia. *Australian Journal of Earth Sciences*.
- Cawood, P.A. (1983). Modal composition and detrital clinopyroxene chemistry of lithic sandstones from the New England Fold Belt (east Australia): a Paleozoic forearc terrane. *Bulletin of the Geological Society of America* **94**, 1199–1214.
- Crook, K.A.W. (1961). Stratigraphy of the Tamworth Group (Lower and Middle Devonian), Tamworth-Nundle District, N.S.W. *Journal and Proceedings of the Royal Society of New South Wales* **94**, 173–188.
- Epstein, A.G., Epstein, J.B. and Harris, L.D. (1977). Conodont color alteration — an index to organic metamorphism. *U.S. Geological Survey Professional Paper* **995**, 1–27.
- Flood, P.G. and Aitchison, J.C. (1988). Tectonostratigraphic terranes of the southern part of the New England Orogen. In 'New England Orogen Tectonics and Metallogensis' (Ed J. D. Kleeman) pp. 7–11. (University of New England, Armidale).

- Flood, P.G. and Aitchison, J.C. (1992). Late Devonian accretion of the Gamilaroi Terrane to eastern Gondwana: provenance linkage suggested by the first appearance of Lachlan Fold Belt-derived quartzarenite. *Australian Journal of Earth Sciences* **39**, 539–544.
- Korsch, R.J. (1977). A framework for the Paleozoic geology of the southern part of the New England Geosyncline. *Journal of the Geological Society of Australia* **25**, 339–355.
- Mawson, R., Talent, J.A. and Furey-Greig, T. (1995). Coincident conodont faunas (late Emsian) from the Yarrol and Tamworth belts of northern New South Wales and central Queensland. *Courier Forschungsinstitut Senckenberg* **182**, 421–445.
- Stratford, J.M.C. and Aitchison, J.C. (1996). Devonian intra-oceanic arc rift sedimentation — facies development in the Gamilaroi terrane, New England orogen, eastern Australia. *Sedimentary Geology* **101**, 173–193.
- Stratford, J.M.C. and Aitchison, J.C. (1997). Lower to Middle Devonian radiolarian assemblages from the Gamilaroi terrane, Glenrock Station, NSW, Australia. *Marine Micropaleontology* **30**, 225–250.
- Stratford, J.M.C. and Aitchison, J.C. (in press). Devonian Lithostratigraphy of the Gamilaroi terrane in the upper Barnard River, NSW. *Australian Journal of Earth Sciences*.

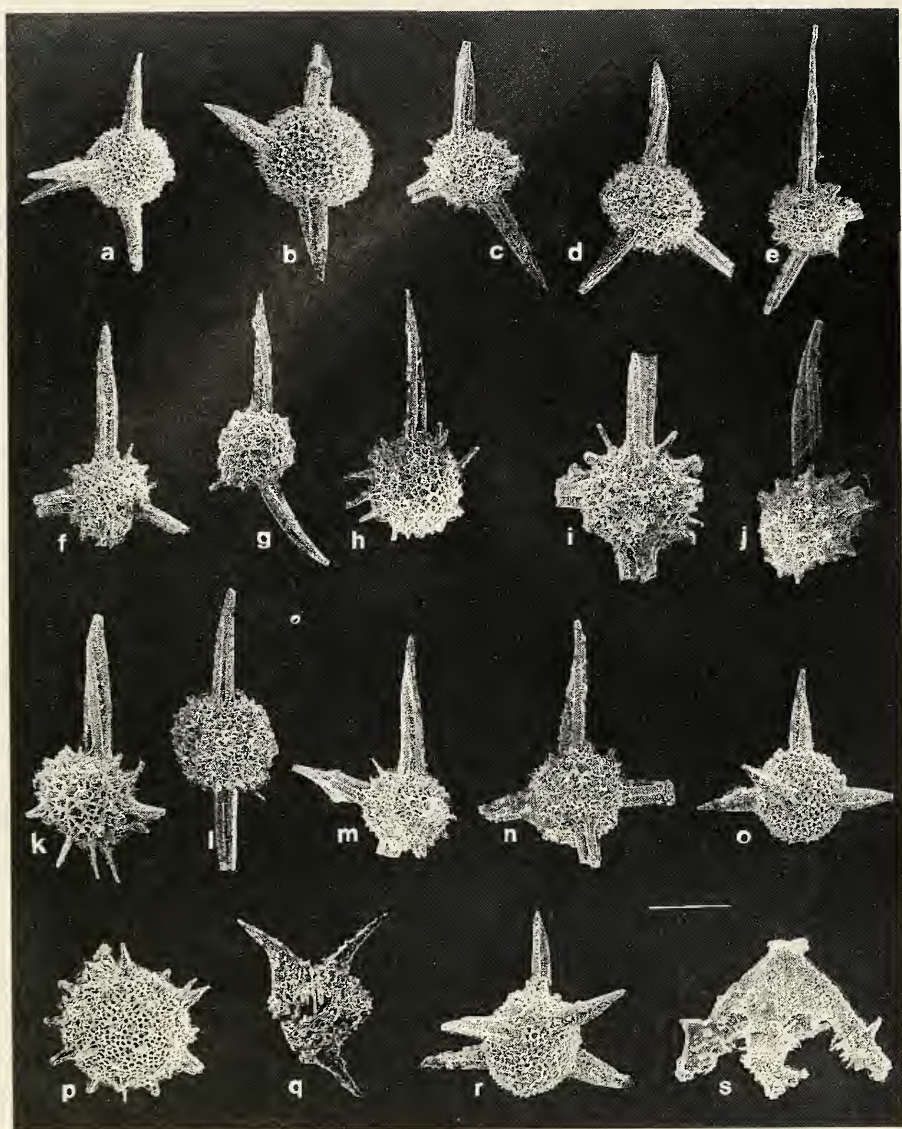


Plate 1: Emsian radiolarians from the Frog Hollow Formation exposed at Glenrock GR543957, Bralga Tops, Glenrock Station, NE NSW. All specimens are housed in the collections of the Department of Earth Sciences, University of Hong Kong. Specimen number and length of scale bar is indicated in parentheses.

1a: *Trilonche* sp. cf. *T. elegans* (Hinde); (HKUDES96/001, 120 μ m), **1b:** *Trilonche* sp. cf. *T. echinata* (Hinde); (HKUDES96/002, 150 μ m), **1c:** *Trilonche* sp. cf. *T. vetusta* Hinde; (HKUDES96/003, 150 μ m), **1d:** *Trilonche* sp. cf. *T. vetusta* Hinde; (HKUDES96/004, 150 μ m), **1e:** *Trilonche* sp. cf. *T. vetusta* Hinde; (HKUDES96/005, 160 μ m), **1f:** *Trilonche* sp. cf. *T. vetusta* Hinde; (HKUDES96/006, 140 μ m), **1g:** *Trilonche* sp. cf. *T. vetusta* Hinde; (HKUDES96/007, 160 μ m), **1h:** *Trilonche* sp. cf. *T. echinata* (Hinde); (HKUDES96/008, 125 μ m), **1i:** *Trilonche* sp. cf. *T. hindea* (Hinde); (HKUDES96/009, 100 μ m), **1j:** *Trilonche* sp. cf. *T. echinata* (Hinde); (HKUDES96/010, 125 μ m), **1k:** *Trilonche* sp. cf. *T. echinata* (Hinde); (HKUDES96/011, 120 μ m), **1l:** ?*Trilonche* sp. cf. *T. hindea* (Hinde); (HKUDES96/012, 140 μ m), **1m:** *Trilonche* sp. cf. *T. hindea* (Hinde); (HKUDES96/013, 140 μ m), **1n:** *Trilonche* sp. cf. *T. hindea* (Hinde); (HKUDES96/014, 125 μ m), **1o:** *Trilonche* sp. cf. *T. elegans* (Hinde); (HKUDES96/015, 90 μ m), **1p:** Entactinid gen. et sp. indet.; (HKUDES96/016, 100 μ m), **1q:** *Ceratoikiscum* sp.; (HKUDES96/017, 80 μ m), **1r:** *Trilonche* sp. cf. *T. elegans* (Hinde); (HKUDES96/018, 100 μ m), **1s:** *Palaeoscenidium cladophorum* Deflandre; (HKUDES96/019, 50 μ m)

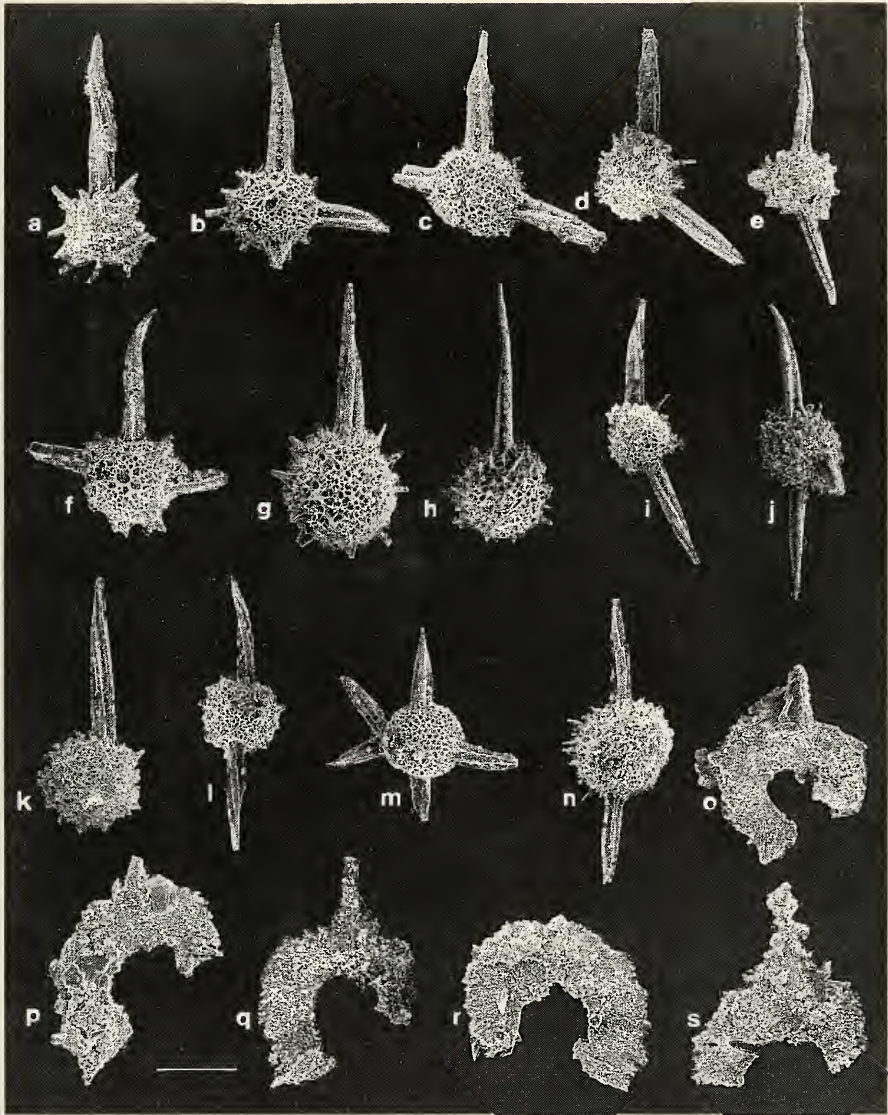


Plate 2: Emsian radiolarians from the Frog Hollow Formation exposed at Glenrock GR543957, Bralga Tops, Glenrock Station, NE NSW. All specimens are housed in the collections of the Department of Earth Sciences, University of Hong Kong. Specimen number and length of scale bar is indicated in parentheses.

2a: Entactinid gen. et sp. indet. (HKUDES96/020, 140 μ m), 2b: *Trilonche* sp. cf. *T. hindea* (Hinde); (HKUDES96/021, 125 μ m), 2c: *Trilonche* sp. cf. *T. hindea* (Hinde); (HKUDES96/022, 125 μ m), 2d: *Trilonche* sp. cf. *T. vetusta* Hinde; (HKUDES96/023, 150 μ m), 2e: *Trilonche* sp. cf. *T. vetusta* Hinde; (HKUDES96/024, 160 μ m), 2f: *Trilonche* sp. cf. *T. hindea* (Hinde); (HKUDES96/025, 125 μ m), 2g: *Trilonche* sp. cf. *T. echinata* (Hinde); (HKUDES96/026, 100 μ m), 2h: *Trilonche* sp. cf. *T. echinata* (Hinde); (HKUDES96/027, 140 μ m), 2i: *Trilonche* sp. cf. *T. vetusta* Hinde; (HKUDES96/028, 160 μ m), 2j: *Trilonche* sp. cf. *T. vetusta* Hinde; (HKUDES96/029, 150 μ m), 2k: *Trilonche* sp. cf. *T. echinata* (Hinde); (HKUDES96/030, 125 μ m), 2l: *Trilonche* sp. cf. *T. vetusta* Hinde; (HKUDES96/031, 150 μ m), 2m: *Trilonche* sp. cf. *T. elegans* (Hinde); (HKUDES96/032, 125 μ m), 2n: *Trilonche vetusta* Hinde; (HKUDES96/033, 140 μ m), 2o: *Helenifore laticlavium* Nazarov (HKUDES96/034, 80 μ m), 2p: *Helenifore laticlavium* Nazarov (HKUDES96/035, 80 μ m), 2q: *Helenifore laticlavium* Nazarov (HKUDES96/036, 80 μ m), 2r: *Helenifore laticlavium* Nazarov (HKUDES96/037, 80 μ m), 2s: *Helenifore laticlavium* Nazarov (HKUDES96/038, 80 μ m)

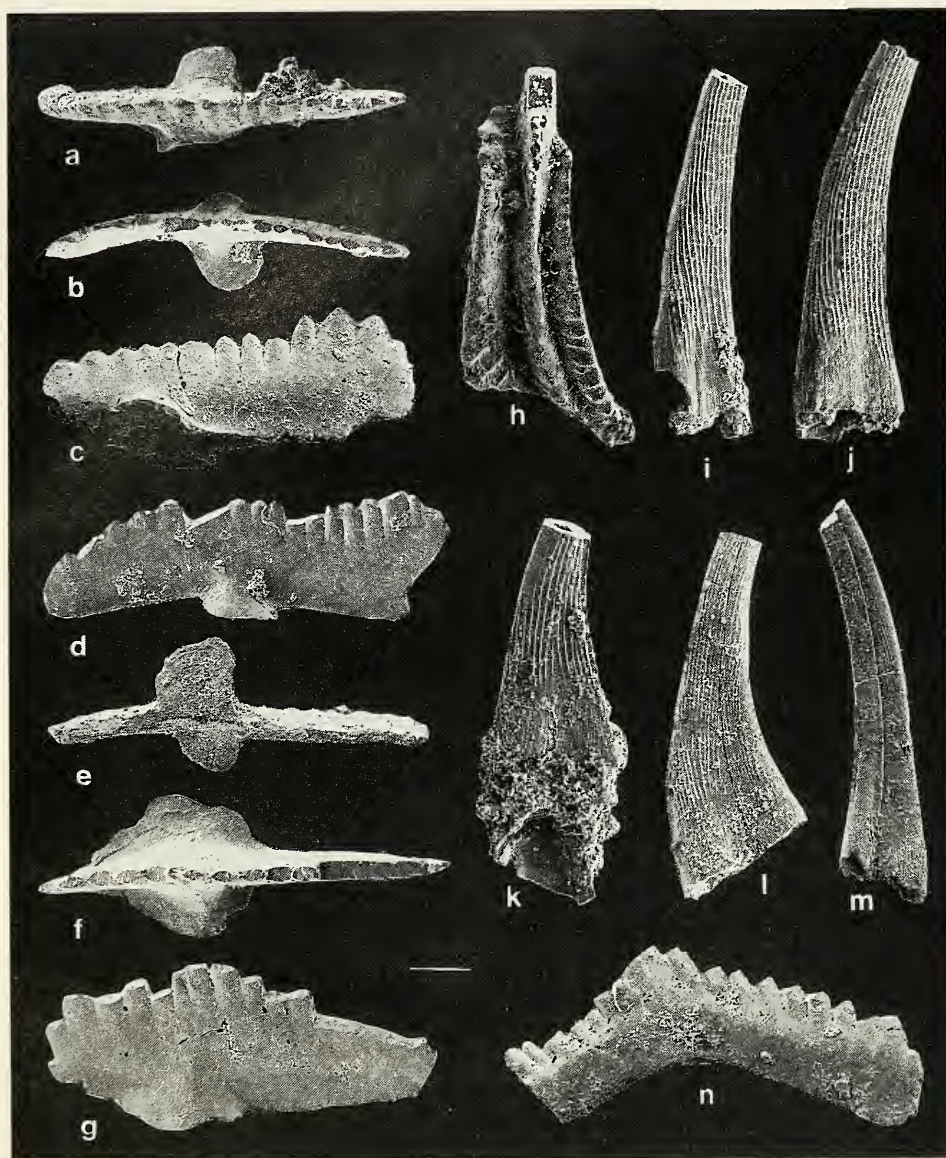


Plate 3: Emsian conodonts from the Frog Hollow Formation exposed at Glenrock GR543957, Bralga Tops, Glenrock Station, NE NSW. All conodont specimens are housed in the collections of the Australian Museum, Sydney. Specimen number and length of scale bar is indicated in parentheses.

3a: *Ozarkodina* cf. *prolata* Mawson Pa, upper view (AMF.100254, 100 µm), 3b: *Ozarkodina* cf. *prolata* Mawson Pa, upper view (AMF.100255, 100 µm), 3c: *Ozarkodina* cf. *prolata* Mawson Pa, lateral view (AMF.100256, 100 µm), 3d: *Ozarkodina* cf. *prolata* Mawson Pa, lateral view (AMF.100257, 100 µm), 3e: *Ozarkodina* cf. *prolata* Mawson Pa, basal view (AMF.100258, 100 µm), 3f: *Pandorinellina expansa* Uyeno and Mason? Pa upper view (AMF.100259, 117 µm), 3g: *Pandorinellina expansa* Uyeno and Mason? Pa lateral view (AMF.100259, 117 µm), 3h: *Polygnathus* cf. *serotinus* Telford Pa, upper view (AMF.100260, 100 µm), 3i: *Neopanderodus aequabilis* Telford Sa, lateral view (AMF.100261, 100 µm), 3j: *Neopanderodus aequabilis* Telford Sa, lateral view (AMF.100262, 100 µm), 3k: *Neopanderodus aequabilis* Telford Sb, lateral view (AMF.100263, 125 µm), 3l: *Neopanderodus aequabilis* Telford M, lateral view (AMF.100264, 125 µm), 3m: *Panderodus unicostatus* Branson and Mehl Sa, lateral view (AMF.100265, 100 µm), 3n: Unidentified Pb element, lateral view (AMF.100266, 100 µm)